PROCEEDINGS

OF

THE ROYAL SOCIETY.

1840. No. 42.

February 27, 1840.

The MARQUIS of NORTHAMPTON, President, in the Chair.

William Jory Henwood, Esq., was balloted for, and duly elected into the Society.

The reading of a paper entitled, "On the Chemical Action of the Rays of the Solar Spectrum on Preparations of Silver and other Substances, both metallic and non-metallic; and on some Photographic processes;" by Sir John F. W. Herschel, Bart., V.P.R.S., &c., was resumed but not concluded.

The President stated to the Meeting, that, accompanied by the Treasurer, Secretary, and other Members of the Council, he had, on Tuesday last, presented the Address to His Royal Highness Prince Albert, to which His Royal Highness returned the following gracious answer:

"It has been the source of great pleasure to me that my arrival in this country should have been hailed with such flattering demonstrations of sincere affection. Amongst the many that have reached me, none have given me more satisfaction than that which I have just received from the Council of the Royal Society."

March 5, 1840.

The MARQUIS of NORTHAMPTON, President, in the Chair.

Captain John Theophilus Boileau was balloted for, and duly elected into the Society.

The reading of a paper entitled, "On the Chemical Action of the Rays of the Solar Spectrum on Preparations of Silver and other Substances, both metallic and non-metallic; and on some Photographic Processes;" by Sir John F. W. Herschel, Bart., V.P.R.S., &c., was resumed and concluded.

The object which the author has in view in this memoir is to place

on record a number of insulated facts and observations respecting the relations both of white light, and of the differently refrangible rays, to various chemical agents which have offered themselves to his notice in the course of his photographic experiments, suggested by the announcement of M. Daguerre's discovery. After recapitulating the heads of his paper on this subject, which was read to the Society on the 14th of March, 1839, he remarks, that one of the most important branches of the inquiry, in point of practical utility, is into the best means of obtaining the exact reproduction of indefinitely multiplied facsimiles of an original photograph, by which alone the publication of originals may be accomplished; and for which purpose the use of paper, or other similar materials, appears to be essentially requisite. In order to avoid circumlocution, the author employs the terms *positive* and *negative* to express, respectively, pictures in which the lights and shades are the same as in nature, or as in the original model, and in which they are the opposite; that is, light representing shade; and shade, light. The terms *direct* and *reverse* are also used to express pictures in which objects appear, as regards right and left, the same as in the original, and the contrary. In respect to photographic publication, the employment of a camera picture avoids the difficulty of a double transfer, which has been found to be a great obstacle to success in the photographic copying of engravings or drawings.

The principal objects of inquiry to which the author has directed his attention in the present paper, are the following. First, the means of fixing photographs; the comparative merits of different chemical agents for effecting which, such as hyposulphite of soda, hydriodite of potash, ferrocyanate of potash, &c., he discusses at some length; and he notices some remarkable properties, in this respect, of a peculiar agent which he has discovered.

2. The means of taking photographic copies and transfers. The author lays great stress on the necessity, for this purpose, of preserving, during the operation, the closest contact of the photographic paper used with the original to be copied.

3. The preparation of photographic paper. Various experiments are detailed, made with the view of discovering modes of increasing the sensitiveness of the paper to the action of light; and particularly of those combinations of chemical substances which, applied either in succession or in combination, prepare it for that action. The operation of the oxide of lead in its saline combinations as a mordent is studied; and the influence which the particular kind of paper used has on the result, is also examined, and various practical rules are deduced from these experiments. The author describes a method of precipitating on glass a coating possessing photographic properties, and thereby of accomplishing a new and curious extension of the art of photography. He observes, that this method of coating glass with films of precipitated argentine, or other compounds, affords the only effectual means of studying their habitudes on exposure to light, and of estimating their degree of sensibility, and other particulars of their deportment under the influence of reagents. After

stating the result of his trials with the iodide, chloride, and bromide of silver, he suggests that trials should be made with the fluoride, from which, if it be found to be decomposed by light, the corrosion of the glass, and consequently an etching, might possibly be obtained, by the liberation of fluorine.

As it is known that light reduces the salts of gold and of platinum, as well as those of silver, the author was induced to make many experiments on the chlorides of these metals, in reference to the objects of photography; the details of which experiments are given. A remarkable property of hydriodic salts, applied, under certain circumstances, to exalt the deoxidating action of light, and even to call into evidence that action, when it did not before exist, or else was masked, is then described.

4. The chemical analysis of the solar spectrum forms the subject of the next section of his paper. It has long been known that rays of different colours and refrangibilities exert very different degrees of energy in effecting chemical changes; and that those occupying the violet end of the spectrum possess the greatest deoxidating powers. But the author finds that these chemical energies are distributed throughout the whole of the spectrum; that they are not a mere function of the refrangibility, but stand in relation to physical qualities of another kind, both of the ray and of the analysing medium; and that this relation is by no means the same as the one which determines the absorptive action of the medium on the colorific rays. His experiments also show that there is a third set of relations concerned in this action, and most materially influencing both the amount and the character of the chemical action on each point of the spectrum; namely, those depending on the physical qualities of the substance on which the rays are received, and whose changes indicate and measure their action.

The author endeavoured to detect the existence of inactive spaces in the chemical spectrum, analogous to the dark lines in the luminous one; but without any marked success. The attempt, however, revealed several curious facts. The maximum of action on the most ordinary description of photographic paper, namely, that prepared with common salt, was found to be, not beyond the violet, but about the confines of the blue and green, near the situation of the ray F in Fraunhofer's scale: and the visible termination of the violet rays nearly bisected the photographic image impressed on the paper: in the visible violet rays there occurred a sort of minimum of action, about one-third of the distance from Fraunhofer's ray H, towards G: the whole of the red, up to about Fraunhofer's line C appears to be inactive; and lastly, the orange-red rays communicate to the paper a brick-red tint passing into green and dark blue. Hence are deduced, first, the absolute necessity of perfect achromaticity in the object-glass of a photographic camera; and secondly, the possibility of the future production of naturally coloured photographs.

5. The extension of the *visible* prismatic spectrum beyond the space ordinarily assigned to it, is stated as one of the results of these researches; the author having discovered that beyond the extreme

violet rays there exist luminous rays affecting the eyes with a sensation, not of violet, or of any other of the recognised prismatic hues, but of a colour which may be called *lavender-grey*, and exerting a powerful deoxidating action.

6. Chemical properties of the red end of the spectrum. The rays occupying this part of the spectrum were found to exert an action of an opposite nature to that of the blue, violet, and lavender rays. When the red rays act on prepared paper in conjunction with the diffused light of the sky, the discolorating influence of the latter is suspended, and the paper remains white; but if the paper has been already discoloured by ordinary light, the red rays change its actual colour to a bright red.

7. The combined action of rays of different degrees of refrangibility is next investigated; and the author inquires more particularly into the effects of the combined action of a red ray with any other single ray in the spectrum; whether any, and what differences exist between the joint, and the successive action of rays of any two different and definite refrangibilities; and whether this action be capable, or not, of producing effects, which neither of them, acting alone, would be competent to produce. The result was that, although the previous action of the less refrangible rays does not appear to modify the subsequent effects produced by the more refrangible; yet the converse of this proposition does not obtain, and the simultaneous action of both produces photographic effects very different from those which either of them, acting separately, are capable of producing.

8. In the next section, the chemical action of the solar spectrum is traced much beyond the extreme red rays, and the red rays themselves are shown to exercise, under certain circumstances, a blackening or deoxidating power.

9. The author then enters into a speculation suggested by some indications which seem to have been afforded of an absorptive action in the sun's atmosphere; of a difference in the chemical agencies of those rays which issue from the central parts of his disc, and those which, emanating from its borders, have undergone the absorptive action of a much greater depth of his atmosphere; and consequently of the existence of an absorptive solar atmosphere extending beyond the luminous one.

10. An account is next given of the effect of the spectrum on certain vegetable colours, as determined by a series of experiments, which the author has commenced, but in which the unfavourable state of the weather has, as yet, prevented him from making much progress.

11. The whitening power of the several rays of the spectrum under the influence of hydriodic salts, on paper variously prepared and previously darkened by the action of solar light. The singular property belonging to the hydriodate of potash of rendering darkened photographic paper susceptible of being whitened by further exposure to light is here analysed, and shown to afford a series of new relations among the different parts of the spectrum, with respect to their chemical actions.

12. The Analysis of the Chemical Rays of the Spectrum by absorbent media, which forms the subject of the next section, opens a singularly wide field of inquiry; and the author describes a variety of remarkable phenomena which have presented themselves in the course of his experiments on this subject. They prove that the photographic properties of coloured media do not conform to their colorific character; the laws of their absorptive action as exerted on the chemical, being different and independent of those on the luminous rays: instances are given of the absence of any darkening effect in green and other rays of the more refrangible kind, which yet produce considerable illumination on the paper that receives them.

13. The exalting and depressing power exercised by certain media, under peculiar circumstances of solar light, on the intensity of its chemical action. This branch of the inquiry was suggested by the fact, noticed by the author in his former communication, that the darkening power of the solar rays was considerably increased by the interposition of a plate of glass in close contact with the photographic paper. The influence of various other media, superposed on prepared paper, was ascertained by experiment, and the results are recorded in a tabular form.

14. The paper concludes with the description of an *Actinograph*, or self-registering Photometer for meteorological purposes: its objects being to obtain a permanent and self-comparable register and measure, first, of the momentary amount of general illumination in the visible hemisphere, which constitutes day-light; and secondly, of the intensity, duration, and interruption of actual sunshine, or, when the sun is not visible, of that point in the clouded sky behind which the sun is situated.

In a postscript, dated March 3rd, 1840, the author states that he has discovered a process by which the calorific rays in the solar spectrum are made to affect a surface properly prepared for that purpose, so as to form what may be called a *thermograph* of the spectrum; in which the intensity of the thermic ray of any given refrangibility is indicated by the degree of whiteness produced on a black ground, by the action of the ray at the points where it is received at that surface, the most remarkable result of which is the insulation of *heat-spots* or thermic images of the sun quite apart from the great body of the thermic spectrum. Thus the whole extent over which prismatic dispersion scatters the sun's rays, including the calorific effect of the least, and the chemical agency of the most refrangible, is considerably more than twice as great as the Newtonian coloured spectrum.

In a second note, communicated March 12, 1840, the author describes his process for rendering visible the thermic spectrum, which consists in smoking one side of very thin white paper till it is completely blackened, exposing the white surface to the spectrum and washing it over with alcohol. The thermic rays, by drying the points on which they impinge more rapidly than the rest of the surface, trace out their extent and the law of their distribution by a whiteness so induced on the general blackness which the whole sur-

face acquires by the absorption of the liquid into the pores of the paper. He also explains a method by which the impression thus made, and which is only transient, can be rendered permanent.

This method of observation is then applied to the further examination of various points connected with the distribution of the thermic rays, the transcalescence of particular media, the polarization of radiant heat (which is easily rendered sensible by this method), &c. The reality of more or less insulated spots of heat distributed at very nearly equal intervals along the axis of the spectrum (and of which the origin is *probably* to be sought in the flint glass prism used—but *possibly* in atmospheric absorption) is established. Of these spots, two of an oval form, are situated, the one nearly at, and the other some distance beyond the extreme red end of the spectrum, and are less distinctly insulated; two, perfectly round and well-insulated, at greater distances in the same direction; and one, very feeble and less satisfactorily made out, at no less a distance beyond the extreme red than 422 parts of a scale in which the whole extent of the Newtonian coloured spectrum occupies 539.

A paper was also read entitled, "Remarks on the Theory of the Dispersion of Light, as connected with Polarization;" by the Rev. Baden Powell, M.A., F.R.S., and Savilian Professor of Geometry, Oxford.

Since the publication of a former paper on the subject referred to, the author has been led to review the subject in connexion with the valuable illustrations given by Mr. Lubbock of the views of Fresnel; and points out, in the present supplement, in what manner the conclusions in that paper will be affected by these considerations.

A paper was also read, entitled, "Further Particulars of the Fall of the Cold Bokkeveld Meteorite;" by Thomas Maclear, Esq., F.R.S., in a letter to Sir John F. W. Herschel, Bart., K.H., V.P.R.S., &c. communicated by Sir John Herschel.

This communication, which is supplementary to the one already made to the Society by Mr. Maclear, contains reports, supported by affidavits, of the circumstances attending the fall of a meteoric mass in a valley near the Cape of Good Hope. The attention of the witnesses had been excited by a loud explosion which took place in the air, previous to the descent of the aerolite, and which was attended by a blue stream of smoke, extending from north to west. Some of the fragments which had been seen to fall, and which had penetrated into the earth, were picked up by the witnesses. One of them falling on grass caused it to smoke; and was too hot to admit of being touched. The mass which was sent to England by H.M.S. Scout, weighed, when first picked up, four pounds. The paper is accompanied by a map of the district, showing the course of the aerolite.

A paper was also read, entitled, "An account of the Shooting Stars of 1095 and 1243;" by Sir Francis Palgrave, K.H., F.R.S., &c.